

face of another young specimen of this Seal in the British Museum, collected in the Australasian Sea by Mr. John Macgillivray.

The Eared Seals are collected for their oil and skins. Most of the species have very dense under-fur of soft erect hairs between the base of the longer hairs. These are called "Fur-Seals;" and the skins, when deprived of their long hairs, are very valuable. The dressed furs of the various species and localities are of very different commercial and economic value. The skins of *Neophoca lobata* of Australia and *Phocarcos Hookeri* of the Southern Ocean, being destitute of this under-fur, are called *Hair-Seals* by the sealers. Their skins are of little comparative value, as they are only used like the skins of the Earless Seals (Phocidæ).

I have not been able to identify the "Tiger Seal" of Musgrave ('Cast away on the Auckland Islands,' pp. 7, 10, 18, 29, &c.), which seems as abundant as the Sea-Lion of the same locality. They are both probably undescribed.

XXXIII.—*Recent Researches on the Fossil Fishes of Mount Lebanon.* By MM. F. J. PICTET and A. HUMBERT*.

THAT the fossil fishes of the coasts of Syria are among those which have been longest known is shown by the mention of them in De Joinville's 'Histoire de Saint-Louis.' This chronicler tells us that, during the sojourn of the Crusaders at Sayette (the ancient Sidon, now *Saida*), "A certain marvellous stone was brought to the king, in appearance like a quantity of scales, of the which when one was raised you saw beneath, between the two stones, the shape of a fish of the sea. And the fish was of stone, but nothing of its form was wanting, neither eyes, nor fins, nor colour, any more than if it had been living. The king asked for one of these stones, and found a tench in it, of a brown colour and like any other tench."

Various travellers, such as J. Korte, C. Lebrun, Volney, &c., have also mentioned these fishes; but Scheuchzer is the oldest naturalist who, as far as we know, has paid any attention to them. In his work '*Piscium Querulæ et Vindiciæ*,' published at Zurich in 1708, we find a passage devoted to the fish figured in Lebrun's '*Voyage*' (Cornelius de Bruyn), and another referring to a specimen in the Woodward Collection. The Zurich natu-

* Translated by A. O'Shaughnessy from a separate impression, communicated by the Authors, from the 'Archives des Sciences de la Bibliothèque Universelle,' Geneva, June 1866. See also '*Nouvelles Recherches sur les Poissons Fossiles du Mont Liban*,' 1 vol., with plates, by F. J. Pictet and A. Humbert: Geneva, 1866.

ralist, however, teaches us nothing more than his predecessors, as he does not describe these fossils or discuss their zoological affinities. De Blainville was the first to study scientifically some of the Lebanon fishes. He described two species belonging to the genus *Clupea*, and called them *Cl. Beurardi* and *Cl. brevissima*.

De Blainville's essay on the Ichthyolites was soon superseded by the labours of Agassiz in 1833-1843. Nevertheless the learned author of the '*Recherches sur les Poissons Fossiles*' possessed actually very slender materials relative to the fauna of Lebanon. He brought to light four new species only, and added some details respecting the two *Clupeæ* described by De Blainville.

In 1845 Sir Philip Grey Egerton described a Ray from the limestones of Hakel; and in 1849 Heckel made known four or five species, brought from Syria by Th. Rotschy. In 1850 one of the present authors published a special memoir on the fishes of the two deposits of Hakel and Sahel Alma, founded upon important materials amassed by MM. E. Boissier and Blondel. In this memoir twenty new species were described.

Since this there has been only one work on the fishes of Lebanon, that of M. O. G. Costa, who has described and figured four new species.

Researches made in 1860 by one of the authors (A. Humbert), in the deposits of the coast of Syria, have greatly enriched the collection of the Museum of Geneva, both in new species and in more perfect examples of such as had been previously described. We have thought it advisable to pass in general review the fishes of Lebanon, completing, whenever we could, the descriptions of the forms already known, and inserting the new species.

We here extract a portion of what we have said in our introduction concerning the age of the two deposits as attested by geological and palæontological evidence; and we also reproduce our general remarks on the two ichthyological faunas of Hakel and Sahel Alma.

Geological data.

The beds which we have been considering are situated on the eastern slope of Lebanon, between Tripoli and Beyrout, nearer, however, to the last-named town. The nature of the rock and the fauna of these two deposits show that they belong to different formations; their age and relative antiquity have, however, not yet been satisfactorily determined.

MM. Agassiz and Heckel, in default of positive information, have done no more than put forward certain hypotheses with respect to the formation to which should be referred the few species which they had within reach.

M. de Tchihatcheff has found at Makrikoi, near the gates of Constantinople, certain fossil fishes identical with those of Hakel. Unfortunately this traveller never saw *in situ* the rock whence the specimens were obtained; and consequently his notices are of little value, except so far as they attest the geographical extension of the beds of Lebanon.

We are consequently almost reduced to the stratigraphical data furnished by M. Botta in his memoir on Libanus and Antilibanus*. M. Botta distinguishes three principal formations in the Lebanon. He refers the lowest of them to the Upper Jurassic period, the following to the Greensand, and the third, which covers this, to the Lower Cretaceous series. The Lower Chalk is composed of an alternation of limestones and calcareous marls. It is in one of the middle beds of this latter formation that the fishes of Hakel occur. With regard to those of Sahel Alma, they belong, according to M. Botta, to the same group, but may be slightly more ancient.

The observations made at Hakel by M. Humbert, although very incomplete, tend to confirm the views of this learned French naturalist. We have, in fact, found fossils characteristically Cenomanian (Upper Greensand), such as *Orca Tailleburgensis*, *Cardium Hillanum*, &c., in layers of alternate limestones and marls, which are immediately overlain by the fish-beds. Possibly, in spite of this superposition, these beds may form part of the same group, and be only a phase of the Cenomanian. A circumstance which would lead us to suppose this to be the case is the fact that in proceeding from the bed of the river to a point situated between the village and the deposit of fishes, and mounting perpendicularly the left flank of the valley, we find a series of calcareous laminæ more or less compact, but without a trace of the fish-bed; the superior laminæ seem, however, to be continuations of those which overlie that bed. We must thence conclude that this latter is superior to the Cenomanian formation, or that it forms part of that formation. If, as we suppose, the *Hippurites lumbricalis* (and perhaps *H. socialis*) obtained between Djebail and Hakel are superior to the fishes of Hakel, then these are inferior to the Turonian (Lower White Chalk) formation.

The beds of Hakel would seem to be prolonged over a very considerable space. The *Clupea Beurardi* was described by De Blainville from a specimen brought from Gibel (Djebail), and probably emanating from Hakel; M. Agassiz studied a specimen from Saint-Jean d'Acre. The *Clupea brevissima*, so abundant at Hakel, is represented in the Museum of Geneva by specimens

* "Observations on Libanus and Antilibanus," by M. P. E. Botta, jun. (Mém. de la Soc. Géol. de France, tome i., 1st part: Paris, 1833).

labelled as coming from Mount Carmel; M. Agassiz saw in the Zurich Museum a specimen of this species sent from Saint-Jean d'Acre*; Mr. Williamson† found it at Gebel-Suneen (very probably Sannina), near Beyrout; and, finally, as we have just seen, M. de Tschihatcheff has procured it at Makrikoi near Constantinople, where it is associated with *Eurypholis Boisseri* and *Cyclobatis oligodactylus*.

The deposit of Hakel must have been formed at a very slight distance from the land; for our late researches afforded a wingless orthopterous insect.

With regard to the second deposit, we have nothing to add to what Botta has said on the subject, with the aid of certain opportunities for comparison which we have not had at our disposal.

The convent of Sahel Alma, situated 17 or 18 kilometres north of Beyrout, is erected on a sharp declivity which descends to the sea. It is immediately beneath the walls of the convent, in a field of mulberry-trees, and covered solely by the vegetable earth, that the calcareous marl containing the fishes occurs. With them we have collected Crustaceans and two Ammonites. These latter fossils are, unfortunately, not sufficiently preserved to admit of a strict determination.

Valenciennes, in examining the fishes collected at Makrikoi by M. Tschihatcheff, found a species of a new genus, which he named, without, however, describing it, *Strymonia sirica*‡. It comes from a light limestone perfectly identical with that of Sahel Alma, while the other species occur in a limestone very similar to that of Hakel. It would seem, therefore, that the two fish-beds of Lebanon are found also at Constantinople.

*Age of the two Ichthyological Faunas of Mount Libanus,
according to palæontological data.*

We think we are able to establish as almost certain that both these faunas belong to the Cretaceous period. It would be, on special grounds, impossible to attribute them to the Jurassic. The greater number of Teleostean fishes which they afford, together with the absence of Ganoids, show them to be unquestionably posterior to that period.

It seems to us no less evident that they are not Tertiary faunas. For proof we have:—

1. The presence of two species of *Ammonites* in the beds of Sahel Alma, and of an *Aptychus* in those of Hakel.

* It is very possible that Saint-Jean d'Acre and Mount Carmel correspond to one and the same locality.

† Proceed. Geol. Soc. Lond. vol. iii. p. 291.

‡ Bull. de la Soc. Géol. de France, 2^e série, 1851, t. viii. p. 301.

2. The existence of a certain number of genera or groups, which, as far as we know at present, characterize the Cretaceous epoch. Such are the genera *Scombroclupea* and *Leptosomus*, the groups of *Dercetis* and *Eurypholis*.

3. The great number of extinct genera which contribute to give these faunas a special physiognomy. These are, at Hakel, *Pseudoberyx*, *Petalopteryx*, *Coccodus*, *Aspidopleurus*, and *Cyclobatis*; and at Sahel Alma, *Pycnosterinx*, *Cheirothrix*, *Rhinellus*, and *Spaniodon*.

4. The fact that among the genera which are still represented by living species, those which are the most abundant at the Lebanon are precisely such as belong also to the Cretaceous epoch. We may mention in particular the type *Beryx*, which is pre-eminently Cretaceous, although represented at the present day by some species in the warmer seas. We may also cite the *Clupeæ*, the existence of which is demonstrated as far back as the Cretaceous period, and the *Chirocentrites*, the maximum development of which is equally characteristic of that epoch.

The fish which are not referable to one or other of these categories are very few in number, and occupy but a subordinate position in the Lebanon faunas.

But, although we are tolerably certain of the general fact that these faunas are Cretaceous, we find it a much more embarrassing matter to decide to which of the subdivisions of this long age they should properly be referred. The history of fossil fish presents still too many breaks to admit of our applying here the same methods as hold good in the case of Mollusks and Echinoderms, and we are forced to content ourselves with a certain degree of probability.

The first point to determine is that no species of Mount Libanus has ever yet been found in any other deposit, save certain parts of Syria and Asia Minor which belong to the same epoch, and of which we have already spoken. Consequently our comparisons become limited to the more uncertain relations between genera and natural groups.

We have compared the faunas of Lebanon with that of Voiron (as made known by one of the authors*), with that of Comen in Istria (as studied by MM. Heckel, Kner, and Steindachner), with that of the Chalk of England, and finally with that of the Chalk of Westphalia (the numerous species of which have been described in an important memoir by M. von der Marck).

Making allowances for insufficient data, we give the following as the results of these comparisons:—

* F. J. Pictet, 'Paléontologie suisse,' 1858, 1^{re} série. Description des fossiles du terrain néocomien des Voiron.

1. The fauna of Hakel has greatest resemblance to that of Comen in Istria. Nevertheless it presents a greater proportion of living genera, and may thus be concluded to be the more recent of the two.

2. The fauna of Sahel Alma is unquestionably related to that of the Chalk of Westphalia.

3. Both one and the other differ to a greater extent from that of the Chalk of England.

4. These differences and resemblances may be partly owing to geographical causes, and partly to the respective ages of the formations. The former would tend to augment the relations with Comen, and to diminish those with the Chalks of more northern countries, and would consequently weaken considerably the importance to be attached to the resemblances.

In spite of doubts so engendered, the precise limit to which it would be impossible to lay down, our general conclusion is that the faunas of the Lebanon are, both the one and the other, intermediate between those of Istria and those of the Upper Chalk, and that, consequently, their position is most probably in the Middle Cretaceous formation.

And here we have to deal with a question both difficult and embarrassing. What is the relative age of our two Lebanon faunas? And which is the more ancient?

Had the labours of Botta resolved this question, and were we already possessed of sufficient stratigraphical proofs, we should not now be forced to have recourse to the hazard of a palæontological analysis, which is the more embarrassing since it leads us to a result quite opposed to that which the above-named author somewhat prematurely regarded as probable. M. Botta believed the fauna of Sahel Alma to be the more ancient. The comparisons which we have lately made, and which have brought us to the conclusion that the fauna of Comen is more nearly related to that of Hakel, while that of Sahel Alma more especially recalls the fauna of the White Chalk, lead us on the contrary to consider the first the more ancient. It is to be hoped that a complete geological survey of these countries will put an end to this uncertainty.

General Palæontological Considerations.

The study of organic development throughout the course of geological time shows that the different classes of the animal kingdom are far from presenting a history uniform in this respect. The epoch, in particular, during which the modifications which have more powerfully affected the organism have taken place would seem to have been by no means the same for the

different classes. We see, at a given moment, a certain class become modified to intensity, while a certain other class preserves its general physiognomy intact, to become subject to a similar process at another period.

The class of fishes is remarkable in this particular*. The last extensive modification it has undergone corresponds to the transition between the Jurassic and Cretaceous periods. Now, with regard to most classes, this transition is relatively of little importance. We see the Jurassic reptiles continuing a great many of their types in the Cretaceous period, whilst the transition between this and the Tertiary period is marked by the most striking changes of form. We see the Mollusks, the Echinoderms, and the Polypes of the cretaceous seas reproducing to a great extent the types of their Jurassic predecessors. If we were to seek the epochs when the greatest modifications in each of these classes have taken place, we should never find them in the interval between the Upper Jurassic and Neocomian periods.

The importance of the change which took place at the termination of the Jurassic period has already been dwelt upon sufficiently by M. Agassiz. Our learned friend has laid stress in particular on the apparition somewhat suddenly at the commencement of the Cretaceous period of the most perfect group of fishes, the Teleostei, which form the large majority of the population of the modern seas. Saving a certain measure of restriction imposed by later researches upon the generality of this assertion, the fact has in the main received every confirmation. It gives a particular importance to the study of the Cretaceous fish-faunas, since these faunas are the origin and, in some measure, the earliest expression of our present existing ones. It is interesting to follow the gradual series of modifications through which they have passed, to note the earliest representative types, the forms which have continued most constant, and those which have been the last to appear. The most generally adopted classification of fishes is that of J. Müller. Of the six subclasses established by him, three have no fossil representatives (*Leptocardii*, *Cyclostomi*, and *Dipnoi*); the three others alone enter the domain of the palæontologist.

Among these three subclasses, the *Elasmobranchi* retain the same general characters which they have presented throughout all time. This is the group which has undergone the least modification. It is not represented very abundantly at Lebanon;

* Prof. Heer has just called attention to a perfectly similar fact in the history of the vegetable kingdom, 'Les Phyllites crétacées du Nebraska' (Extrait des Mém. de la Soc. helvét. des Sc. Nat. 1866). He has shown that the Upper Cretaceous flora is quite different from the Jurassic flora, and allied rather to the Tertiary flora.

there are, however, the two principal types, Sharks and Rays. These fishes are for the most part difficult of comparison with other fossil species; for, in most deposits, the *Elasmobranchi* are only indicated by isolated teeth: in the Lebanon, however, the case is quite different; there are no isolated teeth, but some few entire bodies.

The subclass of the *Ganoids* is, in all known faunas of the Cretaceous period, in rapid course of extinction. This renders all the more interesting the fact that the faunas of the Upper Jura which immediately preceded this period are rich in numerous and fine characteristic species of this subclass. We have not found at Lebanon any true Ganoid; for we no longer retain in that subclass the order Hoplopleuridæ established by one of ourselves. This order belongs properly to the great series of Teleosteans.

This third subclass is consequently by far the most important. It affords almost the total of the fauna, and it is with it that we have more particularly to deal at present.

As we have said above, M. Agassiz did not place the existence of the Teleostei further back than the Cretaceous period; the greater number of authors now, however, recognize an exception to this rule, and regard as Teleosteans in all probability the genera *Tharsis*, *Leptolepis*, &c., with minute rounded scales. Taking for granted the correctness of this view, which it would take us too long to discuss here, we have to notice a very important fact, which is that the Teleostean fishes of which M. Agassiz forms his family Halécoides, and which we know under the names of *Salmones* and *Clupeæ*, are manifestly the nearest relatives of these same Jurassic genera. The numerous family to which these precious types of our present seas belong are actually the descendants of the Jurassic Teleosteans. They have a history longer than that of any other existing family, and may be regarded as, in some sort, the trunk of the genealogical tree of the fishes of our present seas.

It is, further, very interesting to find that these fishes are the ones which present developed in the highest extent the normal characters of their class, and that they thus in some sort represent the archetype thereof. A theoretical anatomist, wishing to set forth this archetype, would be inevitably led to depict a figure almost exactly like that of a Halecoid, since he would assign to it ventrals in the normal position far back on the abdomen, and a mouth with the edge composed of both maxillary and intermaxillary; and nothing is more normal than the fins of a salmon and its regular and fusiform body.

We may, then, assume that the most ancient Teleostean fishes were the most normal in their forms, and that their cha-

acters were continued in the Cretaceous and following periods by the family of the Halecoids.

Our Lebanon faunas are rich in fishes of this family; for out of fifty-one species now known, nineteen belong to it.

Another important type is that of the Teleostean fishes with serrated scales, united by M. Agassiz under the name of Ctenoids. This denomination, which, at the present day, does not correspond to an order of sufficient zoological value, may, however, still be advantageously employed, in the general comparison in which we are now engaged, to designate all those fish which more or less approach the Perch-type in this serrated form of scale, in the spinous rays of their fins, in the tendency of the bones of the head to develop points, &c.

These fishes, less numerous at the Lebanon than the Halecoids, present, however, as we shall now show, certain very distinct forms; they have, however, a common uniform physiognomy, and resemble each other much more than the recent Ctenoids. Variation set in at a later period, and has gone on constantly augmenting to the present day.

The types of prickly-finned fishes which we find at Mount Libanus are the following:—

1. The group *Beryx*, the singular history of which has already been made known by M. Agassiz. At the present day they form part of a small cluster of genera (*Holocentrum*, *Myripristis*, *Beryx*) specially belonging to the Indian seas, allied to the Percoids by their more essential characters, but constituting in that family a tribe characterized by the branchiostegal and ventral rays, which exceed the normal number of seven. This *Beryx*-group, comprising the recent genus and some extinct ones, is the sole representative of the Percoid family during the Cretaceous period. It then existed as the first expression of that family, now so abundant; and after having then constituted it entirely, now exists only as an accessory branch of the same.

2. An interesting and entirely new type, which we have designated *Pseudoberyx*. To the normal characters of *Beryx* it unites that of having the ventrals abdominal—a circumstance of rare occurrence in true prickly-finned fishes. May we not see in this circumstance an indication of a rule similar to that which we have established in the case of the Halecoids, and infer that the first manifestations of types have in general exhibited the tendency to approach the archetypal forms more than the later generations have done?

3. The type of *Pycnosterinx*, already established by Heckel, which in its characters approaches the family Chromidæ, formerly associated partly with the Labroids, partly with the Sciaenoids, but subsequently recognized as distinct, and removed to the group

Pharyngognathi. These fishes, in which Heckel discovered pharyngeal teeth, belong to a type at present very distinct from the Percoids; they approach these, however, through the *Beryx* of the Chalk, which they resemble in scales, fins, and general appearance.

4. The genus *Platax*, of the family Carangidæ, also remarkable for a resemblance in fins and contour to the *Beryx* above named.

Briefly, these four types, now so distinct, were related at the epoch of their origin by certain common characters actually diminished or effaced since then; so that we might represent the history of the Ctenoids by means of a bundle of diverging lines, between which should be inscribed all those families which did not exist before the Cretaceous period.

Some other families of Teleosteans have a few rare representatives at Mount Lebanon. We shall not linger over these, and shall content ourselves with indicating one or two Sparoids, one or two Gobioids, and a curious genus (*Petalopteryx*) belonging probably to the Cataphracti.

In order to render complete this notice of the faunas of Lebanon, it would only remain for us to say a few words relative to an order which we have already named above—that of the Hoplopleuridæ, the relations of which have been contested: this, however, would lead us too far. We would refer to our memoir for the detailed treatment of this question; it will there be seen that all arguments in favour of their affinity with the Ganoids are highly contestable, and that these fishes are true Teleosteans.

The Hoplopleuridæ characterized by longitudinal series of shields form a group at present proper to the Cretaceous period. They themselves contribute largely to stamp the physiognomy of the Lebanon faunas.

These various facts may further be summed up as follows:—

The Lebanon faunas have, like the other Cretaceous faunas, in the more essential points, their relations entirely with the subsequent, and never with preceding faunas. The commencement of the Cretaceous period has been, as concerns this class, a period of great modification and renovation of forms. The principal general character consists in the sudden disappearance of Ganoids, these being replaced by an abundance of Teleosteans.

If we compare them with subsequent faunas (tertiary and modern) we find that they are composed of the same families, only in different proportions.

The most important is that of the Halecoids (*Salmones* and *Clupeæ*), which may be regarded as the continuation of certain Jurassic genera. This is the only family of Teleosteans with so remote an origin. It is also the one which reproduces in the

most marked degree the normal and typical forms of the Fish. The salmon and herrings of our waters are, of all fishes, those which have best preserved the original forms; they are also those which have the longest known pedigrees.

The great Ctenoid division, so varied and important at the present day, has no known root before the Cretaceous epoch. It is represented by a certain number of types bound together by numerous common characters, especially of general appearance and external covering. These types form the base of a large bundle or knot, the various threads of which have become, through successive ages, gradually more and more differentiated and widely removed from each other and the common stock.

The third group which has played an important part in the history of these Teleosteans is that of the Hoplopleuridæ, more isolated than the preceding ones. There is no indication of this group in the Jurassic period, nor any continuation of it in the Tertiary.

These three groups form almost the totality of the Teleosteans. There would now only remain to add, in the present state of our knowledge, some few isolated genera with whose history we are but incompletely acquainted, and which would seem to be subordinate to the preceding ones as much on the ground of this isolation as on that of the small number of individuals representing them.

BIBLIOGRAPHICAL NOTICES.

A History of British Sessile-eyed Crustacea. By C. SPENCE BATE and J. O. WESTWOOD. Part XIII. 8vo. Van Voorst. London, 1866.

THE appearance of a new part of this valuable work, after an interruption of nearly three years (the twelfth part was published in August 1863), leads us to say a few words about it, in the hope that, however we may regret such delays, the interval in the present case may have given time for the training of a new school of students, to whom such a book as this will be welcome.

In the first volume, completed in 1863, the authors nearly finished their descriptions of the British species of true Amphipoda, leaving only the Hyperine forms for the commencement of the second volume. The *Amphipoda aberrantia* of Mr. Spence Bate, including the *Læmodipoda* of Latreille, with the addition of the *Dulichiidæ* of Dana, are completed in the part just published, which also contains the general remarks on the Isopodous order.

In form, the Crustaceans here described are among the most singular of the inhabitants of the sea, although their relationship to the true Amphipoda is so evident that one feels surprised they could